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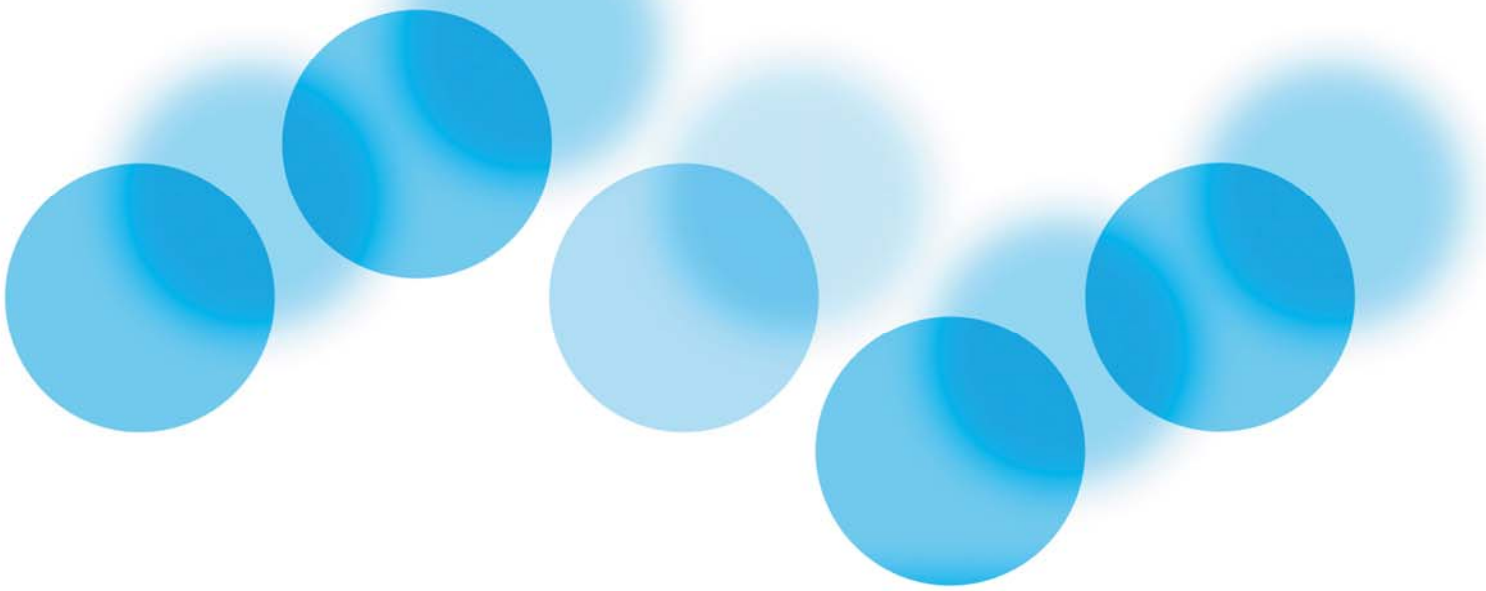
ACCOUNT SIMULATION FOR TARIFFS AND EFFLUENT CHARGES – ASTEC MODEL.

User's Guide to ASTEC 2.0.



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1. INTRODUCTION

The regulatory, economic, and institutional environments of municipal water and wastewater utilities (MWWUs) in Central and Eastern Europe (CEE) are undergoing substantial change. Assets and service responsibilities have been, or are being, transferred from the central government to local levels in most instances, and private participation in operation or ownership of MWWUs is an option in many countries. Meanwhile operating and investment subsidies provided by the central government are reduced, eliminated, and/or subject to new conditions while new sources of financing from external donors or development or commercial banks are more readily available. MWWUs also have to adapt to new or redesigned regulations pertaining to water supply conditions, water quality and effluent standards, and charges, fees, and fines; they must comply with revised and extended oversight of tariff setting, tariff design, and cost recovery; and they now serve a market that is more uncertain and volatile than it used to be. In short, MWWUs are currently beset by a variety of interconnected technical, economic, and organizational challenges.

MWWUs respond to these new challenges and opportunities by adopting a variety of new policies and strategies. Unfortunately, many MWWUs currently lack the data and tools to properly assess the consequences of the planned measures, especially those measures related to tariffs and financing, in the new environment. This limitation is one of the biggest barriers to adoption of effective responses and an important reason why the UNDP-GEF Danube Regional Project (DRP) developed the Accounts Simulation for Tariffs and Effluent Charges (ASTEC) Model. ASTEC is an Excel-based model capable of broadly examining the interaction of a MWWU's tariffs and effluent charges with investment strategies, cost structures, customer behavior, regulatory changes, and physical conditions.

The model is organized around groups of customers, or "service user" (SU) categories. The main features of each service user group are characterized by baseline data, such as number of user accounts, average annual consumption of water and average annual discharge of wastewater, along with the present tariff structure applicable to an SU and the SU's elasticity of demand for services.

Annual revenues from water and wastewater services provided to each SU are computed based on these data. Additional revenues, e.g. revenue from non-core services, grants, subsidies, can also be supplied as inputs to the ASTEC model. In order to bring this organization of data more concretely to mind, we strongly recommend that the reader examine a sample MWWU application – such as **ASTEC 2.0 Demo.xls –** while reading the descriptions in this Users Guide.[2]

The cost data within the model are organized around the service (water or wastewater) as well as the nature of the cost (fixed cost or variable cost).[3] The design and level of effluent charges

[2] 'ASTEC 2.0 Demo.xls' is a simple demonstration version of ASTEC 2.0. This file contains data for a hypothetical water utility and four simple scenarios that illustrate use of the model for several common applications. Specific ranges of the 'ASTEC 2.0 Demo.xls' are displayed at relevant sections of the User's Guide.

[3] The allocation of costs into fixed or variable components may be varied by user. On logical grounds, this determination should reflect a time frame and planning horizon consistent with the policies and investment program to be tested by the model.

assessed on the MWWU is another type of cost that may be included in the model. ASTEC offers several methods for allocating each and every cost item among the SUs, making it possible to estimate the cost of service provision for each customer group. These may then be compared with the revenues to see if revenues are proportionate to costs for that SU.

While water and wastewater tariffs can be supplied to the model exogenously, ASTEC can also be asked to compute tariffs that will just cover all costs. This can be done for customers as a whole or for each service user group. Furthermore, the tariffs computed can reflect a variety of designs e.g., either a simple variable tariff or commodity charge, or as multipart tariff with a fixed charge component. While computing new tariff levels, ASTEC simultaneously calculates new levels of consumption, as customers react to tariff changes.

These features make it possible to investigate the consequences of different operating and development strategies on tariffs and physical and financial accounts. It is possible, for instance, to investigate what happens if cross-financing between industrial and household consumers is ended; to estimate the tariff consequences of a new investment with and without supporting grants; or to identify the most cost-effective strategy for dealing with a newly-introduced effluent charge regulation.

Experience shows that ASTEC is a powerful tool for MWWU managers, municipal decision-makers and policy makers alike. Between 2004 and 2006 it has been applied in seven MWWUs in seven countries of the Danube River Basin. In two "demonstration projects", one in Karlovac, Croatia, and the other in Pitesti, Romania, ASTEC was used as a planning tool for examination of new investments, cost saving measures, and a variety of tariff and tariff-related policy reforms.

In the first phase of the DRP, the original ASTEC model was developed. Working with actual water systems as part of Phase 1 case studies provided many concrete tests of the model and insight into how the model could be further developed to address a greater range of policies, become more user-friendly, and less prone to user, software, and data errors. During Phase 2 of the DRP we kept developing – and applying - ASTEC. The latest version is called ASTEC 2.0 and the present User's Guide describes this version of ASTEC.

ASTEC was developed by Glenn Morris and Andras Kis within the DRP sponsored by the Global Environmental Facility (GEF) and the United Nations Development Program (UNDP). ASTEC is public domain software, and DRP or the developers do not charge for its use. At the same time, however, its developers and sponsors do not warrantee the software or promise to support the software beyond Project-related applications in which they are involved.

While ASTEC is relatively easy for someone with spreadsheet skills to understand and run, experience has shown that it is easy to make mistakes in an ASTEC application if the user does not entirely understand the operational and economic concepts built into ASTEC. It is for this reason that we urge training and supervision in its initial use. The ASTEC model builds on economic concepts and adopts terminology described in this User's Guide and in the spreadsheet comments included in the model itself. These descriptions, however, are meant as reminders and to refresh memory. We encourage prospective users to both consult those who have experience using ASTEC and the DRP Tariffs and Charges related reports and materials for additional descriptions and explanation. These latter materials can be downloaded from the DRP website:

http://www.undp-drp.org/drp/activities_1-6_-7_tariffs_and_charges.html

http://www.undp-drp.org/drp/themes_municipal-ws-ww.html

Further inquiries or comments about ASTEC may be addressed to the developers:

Andras Kis at kis.andras@makk.zpok.hu or Glenn Morris at glennmorris@bellsouth.net

2. TECHNICAL REQUIREMENTS

ASTEC 2.0 requires Microsoft Excel 2000 or a more recent version of Excel, with Solver installed and Excel enabled to run macros.

Solver is installed if you can see it under the Tools menu of Excel. If you cannot see it there, then you need to install it by clicking on Tools / Add-ins and then selecting the Solver Add-in. In some versions of Excel you will need the original Microsoft Office installation disk to complete this process.

Macros can be enabled under Tools / Macro / Security. Here you have three choices of security levels: high, medium and low. High security will not let you run macros at any time, therefore you will be unable to use ASTEC. If you select medium security, then when you open the ASTEC file you will always be prompted with the question if you would like to enable macros, and you should select 'yes'. If you choose low security, then macros will automatically be enabled without asking you each time when you open up ASTEC. However, under this regime you may also be more vulnerable to a special breed of viruses which make use of macros. We advise that you choose medium security, and you enable macros when prompted after you open the ASTEC file.

The user surface of the ASTEC model is presently in English, but ASTEC itself functions independently of the language of the Excel software. Implementing ASTEC using older versions of Excel or on obsolete computers may result in long run-times or it may not be possible at all. If you are experiencing problems running the model, please consult the section on troubleshooting at the end of this User's Guide.

The distributed model – **ASTEC 2.0.xls** - does not contain any data and is a read-only version. When you enter data into it, you need to save it under a different name. This way you will always have a back-up copy of the original, data free, model. This protects the user who inadvertently modifies the model in the process of entering data.

3. THE STRUCTURE AND OPERATION OF THE MODEL

3.1. The Logic of the Model

As introduced above, the main organizing principles of ASTEC are groups of SUs, annual revenue accounts and annual cost accounts of the MWWU.

You can define up to 15 SU categories. These categories are selected on the basis of characteristics that, in the modelers view, distinguish in important ways customer behavior or service. Examples of such distinctions include: services received (water and/or wastewater), consumption levels, water and wastewater tariffs, legal status (households, public entities, commercial enterprises), reaction to changes in price as expressed by the elasticity of demand, technical features (such as individually metered apartments vs. centrally metered block of house), differences in the cost of supplying customers, geographical locations, or any other characteristic deemed important from the perspective of analysis. Each defined service user category is supplied with key variable values, such as consumption levels, tariffs, elasticities, and nonpayment of bills for service. SUs and associated data headings are included in Section 2 of the scenario spreadsheets of **ASTEC 2.0 Demo.xls**.[4]

Annual revenues from tariffs are computed by the model for each scenario based on tariffs and average consumption levels then adjusted for non-payment. The revenue calculations are based on the data of Section 2 of the scenario spreadsheets.

Annual costs are supplied either as fixed costs or variable costs and entered in Sections 3 and 4 of the scenario spreadsheets. A particular category of costs can be allocated among service users automatically based on two methods: proportionate with service use or as a percentage of the cost.

The model keeps track of both costs and revenues for the utility as a whole and for each service user category. As a variable is changed, that will have an impact on either revenues or costs and, sometimes, both of them. ASTEC can also compute cost recovering tariffs under any particular cost or policy scenario.

3.2. Structure of the Model

When you open up the model, you will see that you can select up to fifteen worksheets. These are itemized and available for use on the worksheet toolbar on the bottom of the Excel screen. The model also includes a number of hidden worksheets containing ASTEC programming and side-calculations.

Starting from the left side of the worksheets toolbar on the bottom of the Excel page, we have the following sheets:

The **SideCalc** sheet is an empty sheet in which you can carry out side calculations. You can use it as a notepad and you can store information there. Data from this worksheet does not

[4] Each version of ASTEC has several spreadsheets as described below. One group of spreadsheets holds scenario data and these are labeled S1, S2, etc.

automatically get used for actual model calculations, but data in **Sidecalc** can be referenced from cells on scenarios worksheets (sheets S1 through S10).

The **Glossary sheet** is also a worksheet which is not directly used by the model. It has a list of the various terms used in conjunction with the model and offers explanations for each one. It may be especially useful if you are not familiar with the English financial, engineering, and economic terms used in ASTEC.

The **Control** sheet is used for initiating commands, such as running scenarios, copying one scenario into another one and deleting scenario data.

Scenario sheets **S1** to **S10** contain scenario specific input data. These sheets are to be filled in by the user. While running a scenario, ASTEC makes use of the data in these sheets.

After a scenario has been run, results are displayed in two output sheets. The **Output-Comparative** sheet contains thematic tables with results from all 10 scenarios, thereby making it easy to compare the results of different scenarios. The **Output-By Scenario** sheet contains most of the output of ASTEC, one scenario at a time. The output data for each scenario is presented via a set of tables.

In addition to the worksheets, there is a Visual Basic program code attached to ASTEC, and some of the computing algorithms are stored as instructions within the Solver tool of Excel.

3.3. Operation of the Model

After you have filled in a scenario sheet (any of sheets **S1** … **S10**), then you initiate tasks from the **Control** sheet. When you have clicked on any of the command buttons in the **Control** sheet, the program code behind ASTEC will start running, and the model will start working with data. While running, ASTEC makes use of some of the otherwise hidden worksheets. It can only do so, if these sheets are "unhid" temporarily. If operation of the model is interrupted by the user or by an error, then the otherwise hidden sheets are also displayed. They will, however, be hidden again after the next successful run of the model. After the model successfully finishes running, the results of the scenario will be written in the output sheets and can be examined there.

Some of the scenarios will take only a minute or two to run. Other, more complex scenarios may require a lot of computing time, depending also on the speed of the processor of the computer. The most complicated scenarios on a slower computer may take 15-20 minutes to run.

4. ENTERING DATA

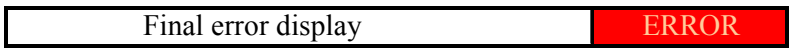
You can enter data into the **Control** sheet and the **Scenario** sheets. In these sheets data for use by the model should be entered into colored cells. Some of the non-colored (white) cells are protected from modification by the user. In others you can enter information, but they will have no impact on the operation of the model.

The user must be careful to enter the correct data, as well as to enter data correctly. This discussion describes the assumptions ASTEC makes about the basis and units of the data entered. Obtaining the correct data to enter any cost entry may require some calculation, adjustment, or calibration on the part of the user. For this purpose, and to keep a record of the data used and its modification, ASTEC also includes an extra spreadsheet for side calculations called **Sidecalc**.

The data that you can enter into some of the colored cells of the sheets is often restricted. For instance, you may enter integers into some cells, or only certain alphabetical text into others. This is important for the safe running of the model – if improper data types are entered, then ASTEC will not know how to handle them and running the ASTEC program code will be halted.

The ASTEC software has a particular logic or structure that has implications for data entry. If entered data is not compatible with the logic of ASTEC, then a red ERROR sign shows up in a cell close to the entered data e.g., in the last row of a table. In the bottom part of the scenario sheets, in cell D217, the ERROR sign shows up if there is any other ERROR sign anywhere in the sheet. This is illustrated below and is ASTEC's way reminding you that at least one entry should be changed somewhere before the model can be run:

Figure 1 Error Sign in ASTEC



Cells, columns, and rows should not be deleted or inserted, because that will change the reference numbers of cells, thereby confusing the model. In fact, as a general principle ASTEC will not let you carry out such deletion or insertion tasks. **Information can be copied between colored cells, but it should never be cut and pasted, because cutting cells will modify the cell references.**

Some cells have comments that are indicated by a little red triangle in the upper right corner. By moving the cursor to the cell, the comment will pop up. These comments usually include guidance on data entry. You can enter your own comments by selecting the cell, and then pressing Ctrl+Shift+i, and then filling in the text of the comment. If you want to delete a comment, you should press Ctrl+Shift+d.

4.1. Control Sheet

Before you start filling in the **Scenario** sheets, there are some cells to be filled in on the **Control** sheet.

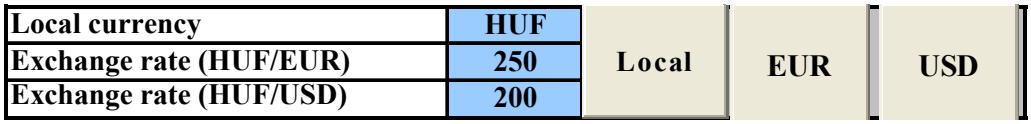
You should enter the number of service user categories in Cell C5. You can use up to 15 different service user categories within ASTEC 2.0. If you, however, organize MWWU customers into fewer

than 15 categories, then the model will carry out computations in less time. In addition, scenario and output sheets will also be easier to use when there are fewer SU categories, since smaller tables will be created and displayed[5]. After you have entered the number of SU categories, you should also press the button right of the cell called "Set number", so that the SU category number entry will take effect:

Figure 2 Setting the Number of Service User Categories

In Cells C21:C23 you should fill in the code for the local currency (like RON for New Romanian Lei, or HRK for Croatian Kuna). Also fill in the exchange rate between the local currency and the EUR and the USD that you want to use. These entries will make sure that the proper currency units are displayed in the scenario and output sheets. Then select the currency in which you want to show results: in ASTEC you can chose to show results in EUR and USD, as well as in the local currency.[6] A sample of these entries and toggle buttons is shown below:

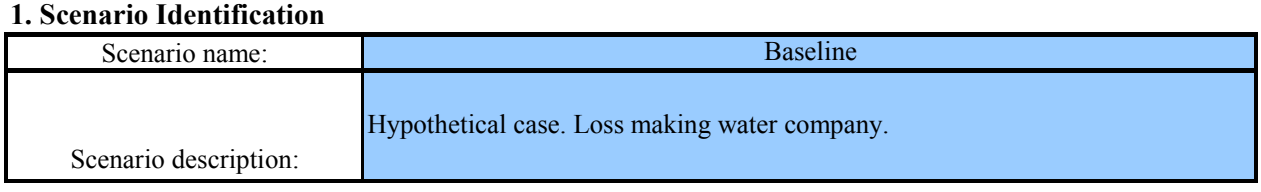
Figure 3 Choosing the Currency of Results



4.2. Scenario Sheets: Definition of Service User Categories

The **Scenario** sheers are the sheets named **S1** to **S10**. Before supplying detailed data on service users, costs and tariff designs, you should fill in the name of the scenario and a short description in Cells C5 and C6 of the scenario sheet you are working in. A sample entry is shown below.

Figure 4 Naming and Describing Scenarios



4.2.1. Service User Account Data

Once the number of service user categories has been set in the **Control** sheet, Section 2 of all ten **Scenario** sheets will include a matrix with this number of rows. You, as user, can fill in this matrix

[5] What actually happens is that the rows of unused service user categories are hidden.

[6] ASTEC will assume that all raw monetary entries are in the "local" currency. The user can, of course, choose to make the Euro or US Dollar the "local" currency.

with the name and data for each service user category. It is important that each scenario has the same number and structure of service user categories. This helps assure that it is proper to compare scenario results.

The main characteristics of service user should be supplied in the range B12:AB26 of scenario sheet **S1**.[7] The first three columns of this light blue data entry range are shown below. This area of **S1** stores information on initial SU conditions, i.e., before any changes take place. Such information may be different in other scenarios sheets **S2** – **S10**, but any modeling requirements (such as introducing cost recovering tariffs) will take place in scenarios run after establishing this initial or baseline scenario in sheet **S1**.

The service user category names should concisely summarize the most important features of consumers in that SU category. This will help you keep track of the features of each SU category when comparing results. Through the name you can differentiate, for instance, between user types (e.g. households, industrial users), you can provide a reference for the type of service (water, wastewater or both), the location of the service area (town, village), and any other distinctive feature of the SU category.

The next column headed "Number of Accounts" in Section 2 of **S1** refers to the actual number of customers as they appear in the books or billing database of the company. In case of household customers, if households are individually billed, then the number of accounts will usually be equal to the number of households. In other cases big apartment buildings with multiple households appear as one account for the company. This is usually the situation when there is only one meter for the whole building, and residents share payment of the bill based on some predetermined formula[8]. You should be aware of situations when there are multiple apartments behind one account, and accordingly adjust any calculations of the burden of the water and wastewater bills falling on an individual household. In still other cases an apartment building has only one, common water meter, consumption is broken down to apartments already within the water company, and bills are issued for each apartment individually according to some rough allocation criteria for water use e.g., the number of residents in each apartment.

The number of accounts may change with scenarios. For instance, if you introduce metering for individual households of big apartment buildings, then the total number of your accounts will increase, while average consumption per account will decrease. In this case you might consider adding another SU category e.g., individually metered apartments in big apartment blocks. In this case, the policy of metering individual apartments in apartment blocks will result in shifts in the number of accounts from the SU category "residential apartment blocks" to "individually metered apartments in residential apartment blocks". It might also result in a reduction in the estimated average use of the "residential apartment block" category.

"The service" column allows the user to specify whether a particular SU category uses only water service (W), only wastewater (sewage) service (S), or both services in a composite way, i.e., they cannot be decoupled from each other (WSc), and both services independently from each other (WSi). In the latter case the two services are not linked, wastewater discharge is determined independently of metered water use, and the service user can choose to abandon one service and switch to an alternative provision, e.g. self-supply, without having to give up the other service.

[7] In case of 15 service user categories. For a lower number of groups a smaller matrix will appear.

[8] There are some commonly applied methods for sharing the water bill, such as based on the number of residents in the apartments, or the size of the apartments (m^2 or number of rooms).

Figure 5 Specification of Service Use

2. Specification of service users

2.1 Service User Account Data

	Service user category	Number of accounts in the service user category	The service
1	**Households - apartments**	**255**	**WSc**
2	**Individual houses water only**	**1 121**	**W**
3	**Individual houses w&ww**	**756**	**WSc**
4	**Large enterprises**	**14**	**WSi**
5	**Small enterprises**	**271**	**WSc**

4.2.2. Water Use and Tariffs

In the next group of columns of Section 2, ASTEC expects you to specify water use and tariff features of the SU categories for the MWWU being modeled. The columns and sample entries (with light blue background) are as follows:

Invoiced water use per account. This is the average annual water consumption within the service user category denominated in m^3/year.

Fixed water tariff per account. Fixed tariff or service charge, excluding VAT, that the individual account will have to pay regardless of water consumption, specified in the selected local currency.

Variable water tariff. The price of one cubic meter of water, excluding VAT, specified in the selected local currency per m^3 of water billed.

Water use to which the customer is entitled for paying the fixed tariff. Under some tariff regimes including a fixed tariff component the first few cubic meters of water use, and frequently also the equivalent wastewater discharge, are not subject to a variable water tariff. The units of this entry are in m^3 per year.

Figure 6 Data on Water Use and Tariffs

Service user category	Invoiced water use per account (m^3/year)	Fixed water tariff per account (HUF/year)	Variable water tariff (HUF/m3)	Water use to which the user is entitled for paying the fixed tariff (m^3/year)
Households - apartments	4 215		250	
Individual houses water only	97		250	
Individual houses w&ww	108		250	
Large enterprises	15 400		450	
Small enterprises	248		450	

Having this latter option also provides the opportunity to represent block tariff systems. In the case of a block tariff system consumption is broken down to blocks and each block has a separate variable price per cubic meter. Block tariffs can be represented in ASTEC if service users are categorized according to their present blocks and all consumption preceding the present block is considered as part of the fixed tariff. As an illustration, assume a tariff design in which there is a fixed tariff of 10 EUR/year, plus a variable tariff of 1 EUR/m^3 for the first 20 m^3 in a given year, then 1.2 EUR/m^3 for all subsequent consumption. In this case service users who consume more than 20 m^3 in a year will fall in the 1.2 EUR/m^3 variable tariff category, and their fixed tariff in ASTEC should be 10+20*1=30 EUR/year, in exchange for which they are entitled for 20 m^3 of water consumption. All additional water consumption will be computed with a price of 1.2 EUR/m^3 by the model.

4.2.3. Wastewater Discharge and Tariffs

In the next group of columns of Section 2, ASTEC asks you to specify wastewater use and tariff features of the SU categories for the MWWU being modeled. The columns and sample entries (with light blue background) are as follows:

- Invoiced wastewater discharge per account. Values are in m^3/year. This variable should only be filled in if water and wastewater services are defined as independent from each other (see 4.2.1 above).
- In all other cases invoiced wastewater discharge will be computed by the model as a percentage of invoiced water use, which is to be supplied in the next column (cells J12:J26).
- The actual invoiced discharge, whether supplied by you or computed by ASTEC, will appear in cells K12:K26.
- Fixed wastewater tariff per account. Fixed wastewater tariff or service charge, excluding VAT, that the individual account will have to pay regardless of the volume of wastewater discharged.
- Variable wastewater tariff. The price imposed on the discharge of 1 m^3 of wastewater, excluding VAT.
- Wastewater use to which the customer is entitled in for paying the fixed tariff. This is the first few cubic meters of discharged wastewater for which the service user does not have to pay variable wastewater tariff. This entitlement is related to either the fixed water or the fixed wastewater tariff. In the first case only the fixed wastewater tariff variable does not have to be filled in.

Figure 7 Data on Wastewater Discharge and Tariffs

Service user category	Invoiced wastewater discharge per account (m^3/year)	Invoiced wastewater discharge as percent of water use	Invoiced discharge per account (m^3/year)	Fixed wastewater tariff per account (HUF/year)	Variable wastewater tariff (HUF/m3)	Wastewater use to which the user is entitled for paying the fixed tariff (m3/year)
Households - apartments		100%	4 215		140	
Individual houses water only			0			
Individual houses w&ww		100%	108		140	
Large enterprises	12 000		12 000		400	
Small enterprises		100%	248		400	

The next section asks for information on differences between billed and discharged wastewater for each SU category. The wastewater discharge of large industrial customers is sometimes metered, but for most service users invoiced wastewater volumes are determined as a percent of water consumption. This is usually 100% but it is sometimes less e.g., 95%. Invoiced and discharged volumes, however, are not always the same. If this is the case, then average annual discharged volumes should be separately entered. This is important since the variable costs of the wastewater treatment services (estimated below) are based on estimates of the actual volumes discharged, as opposed to billed or invoiced volumes. In cells O12:P26 you can indicate if invoiced and discharged volumes are different, and supply discharged volumes as a percent of water use.

Figure 8 Invoiced and Discharged Wastewater Quantities

Service user category	*Are invoiced and actual wastewater discharge the same?*	*If not: actual discharge (percent of water use)*
Households - apartments	*No*	95%
Individual houses water only		
Individual houses w&ww	*No*	90%
Large enterprises	*Yes*	
Small enterprises	*No*	95%

4.2.4. Own Price Elasticity of Demand

The price elasticity of demand is the percentage change in consumption as a result of a one percent increase in the variable tariff of the corresponding service. For instance, if the elasticity of demand for water consumption is –0.2, then one percent increase in the variable water tariff triggers a 0.2 percent reduction in water consumption relative to the initial level. Service users will alter their consumption according to the price elasticity of demand as a result of a marginal change in price only – usually a change in the variable tariff of the last unit of water purchased. A change in the fixed tariff will not usually trigger the same kind of behavioral response, since changing consumption will not alter the payment of the fixed tariff. A change in the fixed tariff will result in an income effect only, which may eventually have minor implications on water consumption, but this effect is not modeled.

Figure 9 Own Price Elasticity of Demand

Service user category	Elasticity of demand for water	Elasticity of demand for wastewater	Elasticity of demand for both services
Households - apartments			-0,1
Individual houses water only	-0,15		
Individual houses w&ww			-0,15
Large enterprises	-0,15	-0,15	
Small enterprises			-0,15

The actual price elasticity values entered, and the location of entry in ASTEC, should vary with the services and their pricing.. The entry options are summarized in the following table.

Type of service	**Elasticity to be supplied**
Water service only (W)	Water elasticity (range Q14:Q22)
Wastewater service only (S)	Wastewater elasticity (range R14:R22)
Water and wastewater services provided independently from each other (WSi)	Water elasticity; wastewater elasticity (ranges Q14:Q22 and R14:R22)
Water and wastewater services provided as composite goods (WSc)	Water and wastewater elasticity for the composite service (range S14:S22)

The price elasticity of demand for composite water and wastewater services is the percentage change in the demand for a unit of this service as a result of a one percent increase in the sum of the variable water tariff and the corresponding variable wastewater tariff together. For instance, if consumption of a cubic meter of water results in 0.9 cubic meter of wastewater discharge, then the composite service comprises of a cubic meter of water consumption and 0.9 cubic meter of wastewater discharge. If the variable tariff of the water service is 1 EUR/m^3 and that of the wastewater service is also 1 EUR/m^3, then an increase of 0.1 EUR/m^3 of water service will result in 5% increase of the variable tariff of the composite service (0.1EUR/2EUR). If the price elasticity of demand for the composite service is –0.2, then 5% increase in the variable tariff will result in 1% decline in consumption of water, and a corresponding 1% decline in the discharge of wastewater.

4.2.5. Value Added Tax (VAT)

Under most VAT regimes, the level of VAT will not enter business decisions. The VAT component paid on business expenditures will simply offset the corresponding portion of VAT received from sales and any VAT balance paid to the central government will be just offset by the remaining VAT revenues received from sales.[9] Since water utilities in general are business entities, and some of the service users are also business entities, VAT should not have a fundamental role in ASTEC's examination of investment and tariff modeling.

Households, however, cannot get a VAT refund. The gross water and wastewater tariff, inclusive of VAT, will all appear as a real expense. In order to account for the different perspectives of households and business entities, the water bill calculations in the output sheets will include the non-refundable VAT paid by the household SU categories. To support this feature, you need to supply ASTEC with the VAT rates and declare whether VAT is refundable for a given SU category. This information is to be entered into range T14:V22 and is illustrated in the figure below.

Please remember that all monetary values should be entered in the model as net values, without VAT.

[9] There may be cases when VAT does have a role in business decisions, subject to e.g. the VAT refund regulations, bookkeeping rules on the VAT part of long-term investments or expected changes in the level of VAT. In the majority of cases, however, VAT is not one of the major factors shaping business decisions.

Figure 10 Setting VAT Information

Service user category	Rate of the VAT for water service	Rate of the VAT for wastewater service	Is the VAT deductible?
Households - apartments	20%	20%	No
Individual houses water only	20%	20%	No
Individual houses w&ww	20%	20%	No
Large enterprises	20%	20%	Yes
Small enterprises	20%	20%	Yes

4.2.6. Unpaid Bills

The user next sets the percentage of unpaid water and wastewater bills for each SU category. If bills are fully paid, then these cells should be left empty or zero should be entered. These values will be used by the model when revenue calculation takes place.

Figure 11 Providing Information on Unpaid Bills

Service user category	Percentage of unpaid water bills	Percentage of unpaid wastewater bills
Households - apartments	3%	3%
Individual houses water only	3%	3%
Individual houses w&ww	5%	5%
Large enterprises		
Small enterprises		

4.2.7. Connect Charges

Many of the water utilities require payment of a connect charge after connecting customers to the water and wastewater networks. The connect charge is a one time payment, and related revenues usually do not modify the financial balance substantially. However, there may be years when lots of new connections are created, and it makes sense to keep track of revenues from connection charges as a separate item. In range Y12:AB26 the user can enter the number of accounts paying connect charges for each service user category and the average value of the charge per account. All connect charges are assumed by ASTEC to be paid in full, even if there are unpaid bills within the SU category. VAT should be excluded when these values are entered.

Figure 12 Connect Charges

Service user category	Number of accounts paying connect charge for water service	Average connect charge per account (HUF/year)	Number of accounts paying connect charge for wastewater service	Average connect charge per account (HUF/year)
Households - apartments				
Individual houses water only	25	70 000		
Individual houses w&ww	15	70 000	15	80 000
Large enterprises				
Small enterprises				

4.3. Scenario Sheets: Unbilled Water and Wastewater

4.3.1. Unbilled water

Unbilled water is produced water which is not billed to any of the service users. It may consist of leakage, which is the actual loss of water from the distribution network, technological use, such as regular flushing of the system, and produced and used, but not billed water, e.g., illegal consumption, free use of water for the fire department or the city park service etc. The volume of unbilled water in m^3/year is entered in cells E27.

Figure 13 Unbilled Water and Wastewater

Unbilled water and wastewater	Unbilled water	300 000
	Baseline water production	1 848 018

Unbilled water is important for modeling purposes since it contributes to costs, while it does not generate revenues. It is applied in the model in this spirit; there are certain cost items that can be associated with unbilled water (e.g., production and pumping of water through the network), and as shown later in section 4.4, they can actually be assigned to the "Unbilled water" sub-account.

If some of the costs are applied to unbilled water while, at the same time, the user requires ASTEC to calculate cost recovering tariffs on the basis of each SUs particular costs, then the costs associated with producing and distributing unbilled water may not be covered by any of the service users. To avoid this, ASTEC asks the user to allocate the costs associated with unbilled water among service user accounts, as described in section 4.4 below.

4.3.2. Unbilled, but Treated Wastewater

In a similar fashion to unbilled water, in most systems there is unbilled, but collected and treated wastewater: water that infiltrates the sewers and storm water may fall in this category. Infiltration is underground water that enters through cracks or gaps in the wastewater pipelines. Storm water is rain, snow melt, or other surface water runoff that is collected by the sewer network when the sewer system also serves as the urban water runoff collection system. Such "combined" storm and wastewater systems are the norm. Within the Danube River Basin there are only a handful of

communities with extended, separated storm water collection systems. Some of the unbilled but treated wastewater may be the result of illegal or undocumented connections.

Figure 14 Unbilled, but Treated Wastewater

Unbilled, but treated wastewater	100 000
Baseline wastewater collected	1 491 681

Sometimes the municipality pays for some of the storm water collection (and treatment), other times there is a special storm water charge paid by service users, but quite often storm water collection does not generate additional revenues for the utility.

"Unbilled, but treated wastewater" is handled by ASTEC in a similar fashion as unbilled water. Costs can be assigned to the collection and treatment of this type of wastewater, and the assigned costs can then be further distributed to SU categories if the option of setting tariffs to fully recovery costs is later selected by the user

4.4. Scenario Sheets: Cost Data

ASTEC asks the user to distinguish between fixed and variable costs. This distinction is important to computing costs and evaluating different investment and policy proposals.

The variable cost is so-called because it varies with the amount of service, usually calculated as m^3 of water or wastewater, provided. This is a "marginal" concept in that we ask how many more units of various inputs will be needed to increase output by one unit. For practical reasons, however, these costs are usually computed as the average cost of those inputs whose use varies directly with the production of each unit of output. Defined this way, the short run marginal and average variable costs are roughly the same. For larger changes, or changes that occur at the very limit of some capacity constraint, the variable cost may include the cost of adding some inputs that have an economic life longer than a year.

The level of fixed costs, on the other hand, is distinguished by being independent of output. The majority of the costs of most MWWUs are made up of fixed costs as opposed to variable costs. This is certainly the case in short and intermediate time frame, the time horizon within which most analysis carried out with ASTEC is undertaken.

ASTEC also handles water and wastewater related costs separately, in order to track the consequences of changes in the structure and level of costs, and also to be able to compute different cost recovering tariffs for each of the two services.

In line with this discussion, ASTEC costs are to be entered by you into four separate sections within Sections 3 and 4 of the **S1** to **S10** scenario spreadsheets of ASTEC:

- 3.1 fixed water costs,
- 3.2 variable water costs,
- 4.1 fixed wastewater costs, and
- 4.2 variable wastewater costs.

In addition to the four listed items, there is another section of the ASTEC scenario spreadsheet (4.3 Effluent charges and fines paid to state regulatory authorities) that addresses costs related to variations in discharged wastewater quality. Essentially this is a wastewater cost category, but a separate section was needed because these costs vary with the quality and amount of wastewater discharged based on regulatory mandates, not the cost of treatment.

All costs associated with provision of water and wastewater service need to be entered somewhere in ASTEC. These entries can be in any of the five sections just described.. Costs related to other services, such as external construction projects, maintenance of assets which are not part of the water system etc., can either be left out of the description of the system entirely. Grants and subsidies are handled by the cost entry sections. Grants and subsidies are, from a numerical point of view, negative costs. For each and every item in cost Sections 3 and 4, you need to indicate whether it is cost, or grant/subsidy except in Section 4.3. In section 4.3, covering effluent-related expenditures, only costs can be entered. The user does this by moving the cursor to the head of each cost column, selecting the toggle box, and then designating the entry information as a cost or grant/subsidy.

Grants or subsidies are monetary transfers to the MWWU that does not have to be repaid. A grant is usually meant to support some investment project. If the transfers need to be repaid, then it is not a grant any more, but a loan. The loan should be designated as such i.e., as a cost item.

When MWWU costs are offset with a grant or a subsidy, then both the costs and grants/subsidies should be entered. They both need to appear as cash flows of the MWWU, the cost or expenditure as a negative cash flow; the grant/subsidy as a positive one.

In the instances when a cost or expenditure is financed through a loan, then it is preferable that only the amortization of the loan appears as cost to the company, in order to avoid double counting of expenditures.

Please note that all cost, grant and subsidy data should be entered without VAT!

4.4.1. Fixed Costs and One-Time Grants for Water Service

4.4.1.1. Entering Fixed Cost Items

Up to 100 cost items, identified by the user as fixed costs, can be entered in Section 3.1. This section is illustrated below. The first column provides a heading/description for each of the row entries. The next column is reserved for adding information on distributing the costs assigned to unbilled water among service user categories. This is discussed in more detail in 0. The rest of the columns of the Section can be filled in by the user with data pertaining to actual cost and grant items. Accounting systems sometimes contain hundreds of cost headings. For use in ASTEC some aggregation is needed. For each cost item the information detailed below needs to be supplied:

In row 33 you need to specify, as discussed above, the nature of the item; whether it is cost or grant. Grants will be handled by the model as negative costs. They should be entered, however, as positive values, just like costs.

The user enters the basis for annualization in row 34. The time period represented by ASTEC scenarios is one financial year, which for most MWWUs is equivalent to one calendar year.[10] The natural period for some of the fixed costs is also one year, e.g., labor costs, rental of office space, outsourced services. However, there are some major cost items which should be spread over several years, especially investments financed through multi-year cash flows. There are two broad strategies for financing large scale investments by: 1. saving for a future expenditure or 2. taking out a loan and repaying the debt over multiple years. The method of financing has an implication on the annual financing need. If a company saves for a future investment, then interest will accrue on its savings, while taking out a debt will require the company to pay interest. Assuming the same financing horizon, the annual burden in the first case - where a payment is made in anticipation of a future investment - is lower. In the latter case – taking a loan in the present and paying principal and interest in the future – the annual payment is higher. You can specify the method of financing in row 34 by selecting "future value payment" for the former strategy or "present value payment" for the later strategy involving taking a loan. .

Next, the name of the cost item should be supplied in row 35. This should concisely describe the most important feature(s) of the fixed cost, investment cost, or grant. The name can refer to the technology, the geographical location, or the service users served by the item. For example, "Water treatment at well A" or "Pipeline to town B".

The amount of the cost or grant is to be entered in row 36. In case of annual expenditures, like annual cost of labor, the annual value should be entered. If there is an investment financed through multi-year cash flows, then the full value of the investment is to be entered, and ASTEC will "annualize" the cost based on the term of the loan or saving horizon and interest rate.

The term of the transaction, in years, is entered in row 37. . In the instance of annual cost items, the user should enter 1 in this row. When a one-time cost is spread through several years, then the duration of financing is to be supplied e.g., an investment is financed through a 5 year loan, then 5 is entered.

The cost of capital or interest rate should be supplied in row 38 when a cost item is financed through a multi-year loan or multi-year savings. Otherwise the cell can be left empty. Depending on the method of financing, either the **real** interest rate paid on savings, or the **real** interest rate on the loan should be supplied. The real interest rate (r) is defined as the nominal rate of return (n) corrected for the rate of inflation (i). Because of compounding, the real rate should be calculated as r= (n-i)/(1+i), where the terms are the decimal equivalents of the percentage rates.

Using the above described data, ASTEC will calculate an annualized value of the savings or the debt, which appears in row 39. These figures will then be further by ASTEC to compute annual expenditures, revenues and financial balances. As a check on data entry and data interpretation, the user should examine row 39 after entering the fixed cost data to see that this value makes sense given the nature of the fixed cost item.

[10] Modelling of multi-year periods is also feasible, in this case each year should be handled as a separate scenario.

Figure 15 Fixed Water Service Costs

3. Costs of providing water service
3.1 Fixed costs and one-time grants for water service

		1	2	3	4	5
Cost or grant		Cost	Cost	Cost	Cost
Select the basis for annual cost recovery		Present v.p.	Present v.p.	Present v.p.	Present v.p.
Name of the item	Unbilled water	Labour	Maintenance	Recent investments	Other costs
Amount of the cost or grant (HUF)		230 000 000	75 000 000	500 000 000	200 000 000
Number of years				10	
Cost of capital (%)				7,00%	
Annualized value (HUF/year)		230 000 000	75 000 000	66 531 543	200 000 000

4.4.1.2. Distributing Costs Among Service User Categories

In order to link the costs associated with provision of services to particular service user categories, costs (and also grants) need to be distributed among the service user categories. This takes place in the data columns of Section 3.1 right below the annualized cost/grant values. The figure below illustrates this portion of S.1, Section 3.1 from the sample version of ASTEC.

For each cost item in row 40, you first need to specify the method for distributing the costs. ASTEC gives you two standard options:

- Selecting "Proportion" from the drop-down menu will result in a proportionate distribution of costs, based on the ratios supplied in the cells directly below row 40. In these cells you determine what fraction of the total value should be allocated to any particular service user group. Figures between 0 and 1 should be entered into the cells. In a closed system these values should add up to 1. The sum of the supplied values is displayed in row 57.
- Selecting "Water used" from the drop-down menu will result in distribution of costs in proportion with consumed water quantities. Not all service user categories have to carry a proportion of the annualized cost/grant. You can select any service user group (but at least one) and the full value of the annualized cost/grant will be distributed among selected service users, in proportion to their consumption of water. Selection of a group takes place by inserting 1 into the corresponding cell in the service user category's row. Otherwise 0 needs to be inserted or the cell has to be left blank. While the model is running, consumption of water within a service user group may change due to changes in tariffs. ASTEC will automatically make corresponding changes in cost distribution.

The names of service user categories are displayed in range B41:B55. Only those service users receiving water service are displayed.

Figure 16 Allocating Fixed Water Service Costs

3. Costs of providing water service
3.1 Fixed costs and one-time grants for water service

	1	2	3
Cost or grant		Cost	Cost
Select the basis for annual cost recovery		Present v.p.	Present v.p.
Name of the item	Unbilled water	Labour	Maintenance
Amount of the cost or grant (HUF)		230 000 000	75 000 000
Number of years			
Cost of capital (%)			
Annualized value (HUF/year)		230 000 000	75 000 000
Distribution of the annual value among service user accounts		Water used	Water used
Households - apartments		1	1
Individual houses water only		1	1
Individual houses w&ww		1	1
Large enterprises		1	1
Small enterprises		1	1
Unbilled water			
Total	0	5	5
Error display			

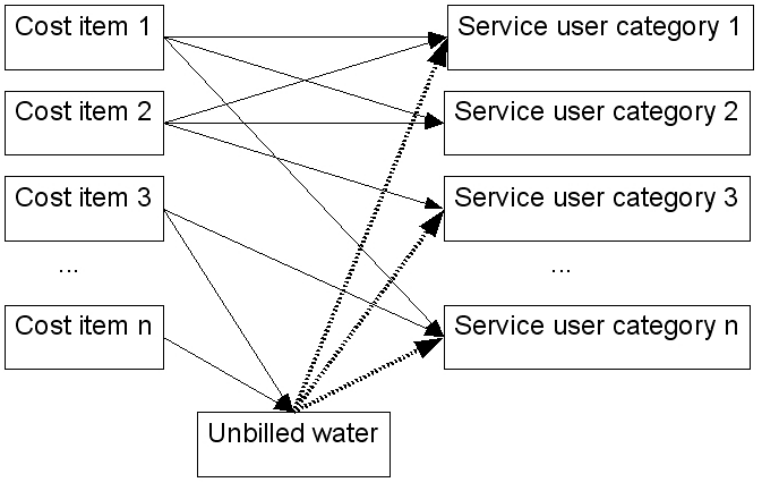
One additional service user category is "Unbilled water". As discussed before, costs can be assigned not only to service users, but also to the category of unbilled water. For instance, you may choose to assign some of the cost of chemicals or electricity used to treat and pump water to this category. This feature of ASTEC is especially useful if you would like to track the costs associated with leakage[11].

The costs related to unbilled water are computed by ASTEC. Since one of the purposes of using ASTEC is estimation of cost recovering tariffs, costs of unbilled water should further be distributed to tariff paying entities, i.e., the service user categories. This can be done in the cells of spreadsheet range C40:C55, in the same fashion as distribution of any of other cost item.

When you are filling in the cells distributing unbilled costs to SU categories, the exact value of the costs associated with unbilled water may not be known. ASTEC will compute unbilled costs while running, using the data for SU categories and the method of distribution provided by the modeler. The method of cost redistribution is illustrated by the figure below.

[11] If you invest into leakage reduction, you need to know your costs before and after the investment, in order to be able to make a reasonable decision on the economic merit of that investment. One can also compare, for instance, the relative merit of leakage reduction in two settings, e.g., a suburb, with many individual houses spread over a large area, and a more densely populated area with large apartment blocks.

Figure 17 Redistribution of Costs Related to Unbilled Water



4.4.2. Variable Costs and Subsidies for Water Service

Variable costs are, again, those costs that vary directly with the output of the MWWU, where output is usually defined in the m^3 of water produced or treated. The user supplies variable costs to ASTEC in Section 3.2 of scenario sheet S1, starting at row 61. An example is provided in the figure below.

These variable water cost data blocks are similar in design to fixed water costs data entry. Up to 100 cost/subsidy items can be entered. As in the case of fixed costs, the user first defines the nature of the item (cost or subsidy), then describes its name and value, and, lastly, determines which SUs use is responsible for imposing this cost item on the MWWU. At the same time, the structure for entering variable costs is a little simpler than the structure for fixed costs, since variable costs do not need to be annualized.

The value of variable costs should be supplied as monetary unit/m^3, e.g., HRK/m^3 in Croatia. The m^3 refers to invoiced quantities since the annual variable costs are computed by ASTEC as the product of the unit cost you enter (monetary unit/m^3) and the consumed quantities. If a given cost item applies to a group of SUs, then this has to be indicated by inserting 1 into the intersection of the service user group row and the cost column.

Just as for fixed costs, any of the variable cost items can also be allocated to unbilled water. In this section, however, the cost of unbilled water cannot be further allocated to service user categories, because all fixed and variable costs associated with unbilled water are redistributed together in section 3.1. In other words, the unbilled water fixed and variable costs are added together and get allocated based on the instructions provided in Section 3.1.

Figure 18 Variable Costs of Water Service

3.2 Variable costs and subsidies for water service

	1	2	3
Cost or subsidy		Cost	Cost
Name of the item	Unbilled water	Chemicals	Energy
Value (HUF/m3)		30,00	25,00
Application of the cost or subsidy to service user accounts			
Households - apartments		1	1
Individual houses water only		1	1
Individual houses w&ww		1	1
Large enterprises		1	1
Small enterprises		1	1
Unbilled water			
Error display			

4.4.3. Fixed Costs and One-Time Grants for Wastewater Service

Fixed cost and grant items for wastewater service are supplied by the user in Section 4.1 of ASTEC scenario spreadsheets **S1-S10**, starting at row 86. The structure of this section is the same as that of Section 3.1 for water. The main difference is that while in section 3.1 costs can be assigned to the unbilled water category, here there is an "unbilled, but treated wastewater" category, referring to collected and treated storm water and infiltrating ground water. We offer a figure showing an example of this data entry block below.

Figure 19 Providing and Allocating Fixed Wastewater Service Costs

4. Costs of providing wastewater service
4.1 Fixed costs and one-time grants for wastewater service

	1	2	3	4	5
Cost or grant		Cost	Cost	Cost	Cost
Select the basis for annual cost recovery		Present v.p.	Present v.p.	Present v.p.	Present v.p.
Name of the item	Unbilled, but treated wastewater	Labour	Maintenance	Treatment of industrial effluents	Other costs
Amount of the cost or grant (HUF)		90 000 000	45 000 000	20 000 000	100 000 000
Number of years					
Cost of capital (%)					
Annualized value (HUF/year)		90 000 000	45 000 000	20 000 000	100 000 000
Distribution of the annual value among service user accounts		Wastewater discharged	Wastewater discharged	Proportion	Wastewater discharged
Households - apartments		1	1		1

Individual houses w&ww		1	1		1
Large enterprises		1	1	1	1
Small enterprises		1	1		1
Unbilled, but treated wastewater					
Total	0	4	4	1	4
Error display					

4.4.4. Variable Costs and Subsidies for Wastewater Service

Variable cost and subsidy items for wastewater service can be supplied in Section 4.2, starting at row 115 of the ASTEC scenario spreadsheets. Section 4.2 is also set up similarly to Section 3.2 for water services as seen in the figure below.

Figure 20 Providing and Allocating Variable Wastewater Service Costs

4.2 Variable costs and subsidies for wastewater service

	1	2	3
Cost or subsidy		Cost	Cost
Name of the item	Unbilled, but treated wastewater	Chemicals	Electricity
Value (HUF/m3)		20,00	45,00
Application of the cost or subsidy to service user accounts			
Households - apartments		1	1

Individual houses w&ww		1	1
Large enterprises		1	1
Small enterprises		1	1
Unbilled, but treated wastewater			
Error display			

4.4.5. Effluent Charges and Fines

Section 4.3, starting at row 139 of the ASTEC scenario spreadsheets, offers you the option to enter wastewater related costs that aren't a function of the volume of wastewater alone. This section was designed specifically to address effluent charges and fines on wastewater discharges. These are entered separately from the rest of the wastewater costs. An effluent charge is assessed on the full amount of effluent discharge of a pollutant subject to the charge, while an effluent fine is imposed only on "above limit" discharges. A portion of Section 4.3 is displayed below.

If effluent charge and fine costs are entered in Section 4.3, then they should not be inserted in Sections 4.1 and 4.2, otherwise ASTEC would account for these costs twice and would overestimate costs.

The computation of the annual effluent charge payment varies with regulatory regimes. In some countries the algorithm is very straightforward, e.g. x EUR/kg of BOD release. In other locations complicated formulae are used, taking into account a wide range of features, like the absorbing capacity of the receiving water body, or the available wastewater treatment technology. ASTEC can be used to keep track of effluent charge or fine payments by major groups of pollutants, but ASTEC is not designed to accommodate all the different possible charge and fine regimes. The user will often have to take into account the particular structure of effluent charges and fines outside of ASTEC and develop an algorithm for transforming them into the simplified design provided in Section 4.3. Such computations can be done outside of ASTEC or on the **SideCalc** sheet of ASTEC. Only the annual payment for each of the key pollutants should be entered in Section 4.3.

In this spirit, in the hypothetical example in Figure 21 the annual payment after BOD releases is set at HUF 12 million. This figure is calculated based on actual BOD effluent discharges and an effluent charge or fine regime. If there is a change in either the regulations or the discharges, then very likely a different annual payment would need to be inserted in the same cell. The new figure would not be calculated by ASTEC automatically, it would have to be entered manually or calculated in the SideCalc sheet and referenced from there to the scenario sheet.

Figure 21 Allocating Effluent Charge and Fine Related Costs

4.3 Effluent charges and fines paid to state regulatory authorities

	1	2
Name of pollutant	BOD	
Annual payment (HUF/year)	12 000 000	
Distribution of the payments among service user accounts	Proportion	
Households - apartments	0,2	

Individual houses w&ww	0,05	
Large enterprises	0,7	
Small enterprises	0,05	
Total	1	0
Error display		

The effluent charge and fine payments can be distributed among service user categories just as fixed wastewater costs. You can select to use either proportion values that you provide exogenously, or let the model determine distribution of the costs in proportion to wastewater discharge by selected groups of SUs.

The effluent charges and fines appear as costs to the water company. The effluent charge component of tariffs can be linked to actual discharges by SUs to the sewer. In this case the effluent charge costs would differ among SU categories, and this can be reflected by adjusting the variable tariffs in each SU category.

4.5. Scenario Sheets: Modeling Tariff and Cost Recovery Options

One of the useful features of ASTEC is that it can be instructed to calculate "cost recovering" tariffs. In fact, ASTEC offers a multitude of choices for achieving cost recovery:

- Those service user categories for which cost recovery must be achieved can be selected individually. Not all service user categories need to be selected for cost recovery, so the MWWU as a whole may not recover all its costs or may have net revenues.
- SU categories can be grouped to achieve cost recovery together, i.e., all service users within such a cluster will have the same tariff design and tariff level, and together they produce enough revenues to just cover the costs of providing service to them. In this case also, the MWWU as a whole may not recover all its costs or may have net revenues.
- Water and wastewater services can be handled separately for cost recovery purposes.
- Several tariff designs are available, including the use of fixed tariffs.

- You can individually determine the tariff design and cost recovery method for each service user group / cluster of service users, including the option to have paying customers cover the costs associated with those customer water and wastewater accounts that go unpaid.
- And lastly, there are several choices to achieve cost recovery for the MWWU as a whole. This feature is useful when cost recovery is not assured for all of the service user categories, but the MWWU still needs to generate sufficient revenues to pay for all its costs.

Since the above features can also be combined with each other, it is possible to test virtually hundreds of cost recovery designs.

Cost recovery options can be set in Section 5 of the scenario sheets, starting at row 162. Section 5.1 sets cost recovery and tariff conditions for water service, Section 5.2 sets cost recovery and tariff conditions for wastewater service, and section 5.3 can be used to sets cost recovery and tariff conditions for the whole MWWU.

4.5.1. Water Tariffs

All of the service users that receive water service are listed in range B165:B179. As a first step, each SU category needs to be assigned into exactly one tariff cluster, by entering 1 at the cross-section of the column of the cluster and the service user row. If a SU category is not assigned to any cluster, or it is assigned to more than one cluster, an "ERROR" message will appear in column D. The model will not run until this logical error is corrected.

All service user categories which belong to the same tariff cluster are subject to the same tariff design and tariff level. A cluster may contain one or more SU categories, but may also be left empty. For instance, if the first three SU categories should have the same tariff designs and tariff levels, then they can all be assigned to Cluster 1 in column E, by entering 1 into each of the cells in range E165:E167, while leaving range E168:E179 empty. In an extreme example, all SU categories can be assigned to one cluster, and all other clusters are left empty. At the other extreme, each service user category may be assigned to a different cluster.

After SU categories have been assigned to clusters you can set the tariff design, tariff level and cost recovery specifications of the SUs included in each cluster. You do this in rows 180-183. First, in row 180, one of five tariff designs needs to be selected for each cluster:

A. "Original tariffs." The tariffs that have been supplied in Section 2 will be used by ASTEC as the MWWUs tariffs.

B. "New tariffs set by the user." You should supply new fixed and variable tariffs in rows 181 and 182 to be used by ASTEC as the MWWUs tariffs.

C. "Cost recovering tariffs with original fixed tariffs." During optimization ASTEC will calculate a new variable tariff which - together with the original fixed tariffs - should generate enough revenue to recover the costs for all the service users within the cluster – but necessarily for the MWWU as a whole.

D. "Cost recovering tariffs with marginal cost pricing." ASTEC will calculate new fixed and variable tariffs. Fixed and variable tariffs should generate enough revenue to recover fixed and variable costs, respectively, for all the service users within the given cluster. While this tariff design has merit on economic efficiency grounds, it is rarely applied in "pure" form due to the high proportion of fixed costs in most MWWUs, but it is sometimes useful to know how closely actual tariffs approximate this design.

E. "Simple marginal cost pricing." Revenue from variable tariffs should recover variable costs, but full cost recovery (of both fixed and variable costs) is not required. This scenario may be useful for experimentation with tariff designs, but the chances for its actual adoption are low given political constraints.

In row 183 you can require that the costs of non-paying customers be recovered by the revenues obtained from those customers within the same tariff cluster who do pay. This feature only applies to tariff designs C, D, and E, since in tariff designs A and B tariffs are set exogenously by the user.

If a mistake has been made during the specification of tariff designs and levels, then an "ERROR" sign will appear for the cluster in row 184. Any of three typical mistakes will prompt the error message:

1. If new fixed and variable tariffs are supplied when they should not be (since they are going to be computed by ASTEC), or if they are not supplied when they should be.
2. When "A. Original tariffs" is selected for tariff design, but more than one service user category appears in the tariff cluster. In this case, the set tariffs of the service user categories may be different, but the tariff cluster assignment says that the user wants them to have the same tariffs.
3. When at least one service user group is part of a tariff cluster but no tariff design has been selected for the cluster.

Figure 22 Setting Water Tariff Designs and Levels

5. Modelling tariff and cost recovery options
5.1 Water tariffs

Service users	Service	Error display	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6	Cluster 7
Households - apartments	WSc		1						
Individual houses water only	W			1					
Individual houses w&ww	WSc				1				
Large enterprises	WSi					1			
Small enterprises	WSc						1		
Select tariff design			A	A	A	A	A		
New fixed tariff (HUF/year)									
New variable tariff (HUF/m3)									
Recovery of the costs of non-payers									
Error display									

4.5.2. Wastewater Tariffs

In section 5.2, starting in row 187 wastewater tariff designs and tariff levels can be specified in the exact same way as in section 5.1 for water.

Figure 23 Setting Water Tariff Designs and Levels

5.2 Wastewater tariffs

Service users	Service	Error display	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6
Households - apartments	WSc		1					
---	W							
Individual houses w&ww	WSc			1				
Large enterprises	WSi				1			
Small enterprises	WSc					1		
Select tariff design			A	D	A	A		
New fixed tariff (/year)								
New variable tariff (/m3)								
Recovery of the costs of non-payers								
Error display								

4.5.3. Full Cost Recovery

If you use original or newly supplied tariffs for any of the clusters without requiring ASTEC to compute cost recovering tariffs, then full cost recovery for the whole utility is not assured, despite requiring cost recovery for some tariff clusters of service users. Even in cases when full cost recovery is required for all clusters, but the costs of non-paying customers are excluded, the system as a whole may not break even financially. Therefore section 5.3 offers an option to achieve system-wide full cost recovery, by uniformly adjusting tariffs until all annual costs are recovered by annual revenues.

Algorithmically, ASTEC will first compute individual tariffs for each cluster and both services, and then changes those tariffs which are not exogenously set, with the same percentage value in order to achieve full cost recovery for all service users together, excluding those SUs with exogenous tariffs.

Four methods of system-wide full cost recovery are offered by ASTEC:

A. System-wide full cost recovery, separately for water and wastewater services, by changing those fixed and variable tariffs that have been derived by the model.

B. System-wide full cost recovery, separately for water and wastewater services, by changing only those variable tariffs that have been derived by the model.

C. System-wide full cost recovery, together for water and wastewater services, by changing those fixed and variable tariffs that have been derived by the model.

D. System-wide full cost recovery, together for water and wastewater services, by changing only those variable tariffs that have been derived by the model.

If all tariffs are determined by the user, i.e., either tariff design "A. Original tariffs" or "B. New tariffs set by the user" are selected, then the model cannot attain system-wide full cost recovery. If the user chooses system-wide full cost recovery, then an error sign will be displayed in cell D214.

Finally, if anywhere in the scenario spreadsheet there is an ERROR message, cell D217 will show "ERROR". This further alerts the user that there is an error that needs to be located and corrected before the model will be ready to run.

5. PROTECTION OF THE USER SURFACE

ASTEC is an application using Microsoft Excel. Excel offers many user options: a wide variety data types can be entered into cells; rows, columns and worksheets can be inserted and deleted; and commands can be initiated from the menu bar or with specific combinations of keys, etc. While all this is very handy for the use of Excel, it is also a potential source of unintended problems for use of ASTEC. For example, entering the wrong data type in a cell, e.g., alphabetical text instead of a number, may disrupt ASTEC computations.

In order to avoid such mistakes, the type of data that can be entered is restricted for all cells. Furthermore, some cells, containing formulae, are protected altogether: you cannot change them. Rows and columns are also protected: they cannot be inserted or deleted on a worksheet. In addition, there are several hidden worksheets on which calculations are carried out, but which are not displayed for reasons of security, as well as to avoid overwhelming the user with unnecessary or intermediate information. Some of these worksheets are "unhidden" during the run of ASTEC, because certain tasks cannot be carried out on hidden Excel spreadsheets, but they are hidden again once ASTEC is finished running. If running of ASTEC is interrupted, then these sheets will be on display until an ASTEC run is completed and it hides them again.

You can insert new worksheets into ASTEC in order to carry out calculations or make notes but. This is only possible when the structure of the workbook (the ASTEC file) is not protected. Un-protecting the workbook allows one to delete or move around worksheets. Moving around worksheets does not threaten the integrity of the model. Deleting worksheets, however, may cause malfunctions. Therefore we warn you not to delete any of the original ASTEC worksheets.

One "side-effect" of protecting the content of the worksheets is that comments to cells cannot be entered or deleted, because this task is also subject to the general protection used by Excel. To circumvent this problem, we made it possible to enter and delete comments through specific key combinations:

To enter a comment to a cell, first you need to select the cell and the press Ctrl+Shift+i. A window will appear in which a comment can be entered and the comment will then be attached to the cell.

To delete an existing comment, select the cell, then press Ctrl+Shift+d.

6. OPERATING ASTEC

Operation of ASTEC is initiated on the **Control** spreadsheet.

As already discussed in Section 4.1 above, the number of service user categories needs to be supplied in Cell C5 before data are entered in the scenario sheets **S1..S10**.

You can copy data from one scenario into another by inserting the number of the source scenario spreadsheet into cell C10 of the **Control** worksheet and the target scenario spreadsheet number into cell D10, and hitting the "Copy" button. This feature is useful when you would like to create a new scenario by modifying an existing scenario. Fragment of the **Control** spreadsheet including this feature and other ASTEC features are shown below.

Figure 24 Copying Data from One Scenario to the Other

Copy scenario data	From scenario	To scenario	Copy
	3	4	

Likewise, you can delete scenario data by inserting its number into cell C13 of the **Control** spreadsheet and hitting the "Delete" button. This is quicker and less troublesome than manually deleting the content of the cells on a given scenario sheet. Be aware, however, that the results of previous runs of this scenario will also be deleted from the output sheets.

Figure 25 Deleting Data from a Scenario

Delete scenario data		Delete

If you wish to run a scenario, insert its number into cell C17 of the **Control** spreadsheet and hit the "Run" button. ASTEC will only be run if proper data and instructions have been supplied on the scenario sheet. If there is an ERROR sign in Cell D217 of the scenario sheet, then ASTEC will give you a signal and refuse running, since erroneous data will produce misleading outputs or it may cause a break down in ASTEC.

Figure 26 Running a Scenario

Run scenario	4	Run

In addition to the local currency, results of the scenarios can be automatically displayed in EUR and USD. The exchange rates supplied in **Control** range C22:C23 will be used to convert the results to these two currencies. Please note that the monetary data supplied by the user to the scenario sheets should always be in local currency. Scenario sheet data will not be converted to other currencies by ASTEC. The user can, however, choose at the outset to make either the Euro or any other currency the "local currency".

Figure 27 Setting Exchange Rates and Choosing the Currency in which Results are Displayed

Local currency	HUF	Local	EUR	USD
Exchange rate (HUF/EUR)	250			
Exchange rate (HUF/USD)	200			

Control spreadsheet range B28:F37 provides historic information about the scenarios. As illustrated below, these cells display the date and time of the last run of each scenario spreadsheet, the time needed to run the scenario, and whether "satisfactory" results were produced. Results are usually identified as unsatisfactory when the set of equations describing the scenario cannot be solved. Such a situation may occur when initial conditions are so disparate that Excel software cannot find an equilibrium. In our case studies, we have never encountered this problem. However, during experiments with ASTEC it was possible to create artificial data and equation sets which were impossible to solve.

Figure 28 Summary Table on Scenario Runs

	Details of the last run				
	Scenario name	Date	Time	Duration	Satisfactory results
S1	Baseline	2007.03.28	11:37:40	0:00:55	Yes
S2	Cost recovering tariffs	2007.03.28	11:49:22	0:02:27	Yes
S3	Third stage treatment	2007.03.28	12:04:29	0:03:43	Yes
S4	Fixed tariff for households	2007.03.28	12:19:56	0:02:21	Yes
S5	0				
S6	0				
S7	0				
S8	0				
S9	0				
S10	0				

7. OUTPUT TABLES

ASTEC displays the same output information in two ways, in two separate spreadsheets: the **Output-Comparative** and **Output by Scenario** spreadsheets.

The **Output-Comparative** worksheet has 33 tables, each containing the values of one variable for all service user categories and all scenarios. This sheet makes comparison of results from different scenario spreadsheets much easier. Below are two tables as examples.

Figure 29 Selected Comparative Output Tables

6	Invoiced water use and unbilled water (m^3/year)				
	Service user category	S1	S2	S3	S4
1	Households - apartments	1 074 825	1 016 906	1 000 303	1 000 372
2	Individual houses water only	108 737	99 823	99 639	101 081
3	Individual houses w&ww	81 648	75 138	73 305	74 093
4	Large enterprises	215 600	216 169	215 771	215 840
5	Small enterprises	67 208	68 194	66 623	67 816
	Total billed water	1 548 018	1 476 230	1 455 642	1 459 202
	Unbilled water	300 000	300 000	300 000	300 000
	Total water	1 848 018	1 776 230	1 755 642	1 759 202

27	Financial balance - both services together (HUF/year)					
	Service user category	S1	S2	S3	S4	S5
1	Households - apartments	-284 036 490	-874 003	-1 271 478	0	
2	Individual houses water only	-18 942 217	0	0	0	
3	Individual houses w&ww	-20 587 914	874 003	1 271 478	0	
4	Large enterprises	12 077 570	-6 266 131	-6 639 179	0	
5	Small enterprises	13 155 092	6 266 131	6 639 179	0	
	Total	-298 333 959	0	0	0	0

The other worksheet, **Output-By Scenario**, provides roughly the same information organized in a different format. The spreadsheet has 10 sections, one for each scenario, and thematic tables which usually include several variables for all the SU categories. Below some of the thematic tables are shown for illustration.

Figure 30 Selected Output Tables from the Output-By Scenario Worksheet

S1	Physical flows						
	Service user category	Invoiced water use per account (m^3/year)	Invoiced wastewater discharge per account (m^3/year)	Actual wastewater discharge per account (m^3/year)	Total invoiced water use (m^3/year)	Invoiced wastewater discharge (m^3/year)	Total actual wastewater discharge (m^3/year)
1	Households - apartments	4 215,00	4 215,00	4 004,25	1 074 825	1 074 825	1 021 084
2	Individual houses water only	97,00	0,00	0,00	108 737	0	0
3	Individual houses w&ww	108,00	108,00	97,20	81 648	81 648	73 483
4	Large enterprises	15 400,00	12 000,00	12 000,00	215 600	168 000	168 000
5	Small enterprises	248,00	248,00	235,60	67 208	67 208	63 848
	Unbilled water / wastewater	300 000,00	-	100 000,00	300 000	-	100 000
	Total	-	-	-	1 848 018	1 391 681	1 426 415

S1	Service user accounts and tariffs				
	Service user category	Number of accounts in the service user category	The service	Fixed water tariff per account (HUF/year)	Variable water tariff (HUF/m3)
1	Households - apartments	255	WSc	0,00	250,00
2	Individual houses water only	1 121	W	0,00	250,00
3	Individual houses w&ww	756	WSc	0,00	250,00
4	Large enterprises	14	WSi	0,00	450,00
5	Small enterprises	271	WSc	0,00	450,00
	Total	2 417	-	-	-

Financial information on the two output spreadsheets excludes the Value Added Tax with two notable exceptions: monthly water bills and monthly wastewater bills for SUs that are households. Households are final users of the services and cannot get the VAT reimbursed. Therefore the VAT is an actual budgetary burden for them.

The information displayed on the output sheets is protected from modification, in order to keep the integrity of the output tables. The information, however, can be copied to another Excel file, where it can be used for further computations.

Output information, as indicated before, can be displayed in local currency, EUR and USD, by clicking on the appropriate button on the **Control** sheet.

8. TIPS ON EFFECTIVE USE

Based on our own experience, as well as feedback from ASTEC users at our case study sites, we assembled a few tips on how to best operate ASTEC. Some of the advice below will seem overly obvious to experienced modelers, but may be helpful to beginners.

- Keep good records of your data. Data comes from many different sources, some data are actually measured, some are computed, others are estimated. ASTEC can use vast amounts of data, and it is easy to lose track of the source, meaning, and reference year of some of this data. Thorough and structured record keeping of input data will also help to uncover data inconsistencies that, when corrected, help improve the reliability of modeling results.
- Make use of the **SideCalc** sheet within ASTEC. This is a sheet where you can do all sorts of calculations, and actually arrive at data used for modelling. Instead of copying data from the **SideCalc** to the scenario sheets **S1..S10**, you can actually reference them in the scenario spreadsheets. If you do this, changes you make to your original data in **SideCalc** will automatically appear in the relevant scenario spreadsheets.
- You can insert comments to cells, so it will be easier to remember your assumptions, source of data etc. This also helps to convey this information to new users of your MWWU-specific ASTEC files.
- Be sure to name your scenarios and explain the underlying assumptions at the top of the **S1** …**S10** scenario sheets. And when you change a scenario, be sure to remember to change this scenario name and description.
- Service user categories should be uniform across scenarios; otherwise scenarios results will not be comparable.
- Keep a backup copy of both the original ASTEC file (without data in it) and your versions of ASTEC. While working with ASTEC, regularly save the files.
- If you'd like to understand the interrelations in your system, change one variable at a time to see what impact that has on revenues, costs, production volumes etc.
- Be patient while the model is running. If you start hitting the keyboard in hope of some response, the response you may get is that ASTEC will terminate the run before it finishes computations.

9. TROUBLESHOOTING

9.1. Settings within Excel

ASTEC was prepared in Excel 2000 and tested both in Excel 2000 subsequent versions of Microsoft Office. In all of these softwares the model worked without problems. In earlier versions of Excel, however, the model may not work properly.

If ASTEC does not run properly, or does not run at all, then try the following remedies:

- Excel should be enabled to run macros. You can do this at Tools/Macro/Safety, choosing mid level safety. Any time when the model is opened, you will be asked if you would like to open the macros, and you can say yes. The changed macro safety setting will only take effect when ASTEC is opened up the next time.
- Solver should be installed in Excel. You can check this on any of the sheets at Tools/Solver. If the Solver window pops up, then Solver is installed. If it is not installed, you can do it at Tools/Add-ins. You may need the Excel installation disk for this.
- A number of items need to be installed within the Visual Basic Editor of Excel (Visual Basic is the programming language in which the ASTEC macros were written). You can reach the Visual Basic Editor by hitting Alt+F11 on any of the worksheets. Then go to Tools/References and check if the following items are marked or not:
    1. Visual Basic for Applications
    2. Microsoft Excel 9.0 Object Library (a different version number may appear for different versions of Excel)
    3. OLE Automation
    4. Solver.xls (or Solver.xla)
    5. Microsoft Forms 2.0 Object Library (or a different version number). If any of the above are unmarked, you need to mark them.

If you do not find Solver.xls or xla in the list, which is a reference sometimes missing, then you need to hit "Browse" and go to the project library where solver is located. Most often this library is ProgramFiles/Microsoft Office/Office/Makro/Solver/Solver. If you do not have such a library, then you need to find the location of Solver from Windows Explorer with the „Find" tool.

Sometimes Solver is installed in your version of Excel but you still receive an error message when you try to run the model. As a remedy to this problem, try the following:

- Go to any of the spreadsheets and open the Solver window (Tools/Solver) and then close it. For some reason this action (sometimes) "wakes up" Solver.
- Unmark and then mark again Solver within the Visual Basic Editor, Tools/References.

9.2. Data Problems

We have tried to assure that ASTEC accepts only proper data types in any given cell. Data incompatibility should not be a cause for problems. An order of magnitude mistake in entry may create problems, however. If, for instance, costs are provided in thousands of units of local currencies, while tariffs are provided in simple currency units, then the large gap between costs and revenues will be difficult, if not impossible for ASTEC to fill.

ANNEX 1: GLOSSARY

One of the ASTEC spreadsheets is the **Glossary**. The glossary provides definitions, descriptions, and background on many of the specialized technical or financial terms used in ASTEC or in supporting documentation like this Users Guide. The glossary can be accessed when ASTEC is open but here we provide another source for the ASTEC **Glossary**.

Term	Explanation
Composite goods	The term "composite good", as used here, refers to the situation when one good or service is billed on the basis of the amount of another good or service consumed. In the most common case encountered, the amount of wastewater service provided to an individual customer is estimated based on the amount of domestic water consumed. The two goods may or may not have different prices. This method of billing the non-measured good or service is imperfect but may be economically efficient if 1) the consumption of one good is highly correlated with the consumption of the other and 2) measuring the consumption of the individual goods is relatively expensive. Usually water and wastewater service satisfy these two conditions.
Invoice	An "invoice", sometimes also called a "bill", is a document sent from the municipal water and wastewater utility (MWWU) to each customer. This document states how much service has been provided and how much the customer owes the MWWU for this service. The invoice or bill may also contain information on how the amount owed has been calculated and other information related to the service provided. The amount of money actually collected from the customer may differ from the amount invoiced for a variety of reasons, including, most particularly, non-payment.
Connect Charge	This may be either a periodic e.g., monthly, or one time charge assessed on a customer to recover the cost of materials such as pipes and meters, machinery, and labor used to connect that customer to the water or wastewater system.
Fixed Charge	See "Fixed Water Tariff"
Elasticity of Demand for Water and Wastewater Service	The "elasticity of demand" is a measure of the responsiveness of consumption to a change in the price of a good or service. It is usually measured as the ratio of the percentage change in consumption to percentage change in price. In this case, it is an estimate of the percentage change in wastewater service consumption, measured in m^3 per period, divided by the percentage change in price, measured in monetary units per m^3. Price elasticity of demand refers to the average service user within a group, including also those which do not react to changes in tariffs. The higher the share of non-paying customers, the lower the response in consumption to changes in price will be.
Fixed Costs	Those costs the value of which do not change with changes in the volume of production or consumption. Depending on the length of the examined period, a certain cost item may be fixed or variable cost. On the short run, the majority of the costs of water systems are usually fixed costs.

Term	Explanation
Fixed Water Tariff	The "fixed water tariff" is charged to customers as a fixed amount per unit of time. For example, a 0.5 Euro per month per account. The fixed water tariff is sometimes called a "fixed charge" and it does not vary with the amount of water consumed. The customer pays the fixed water tariff just for the privilege of accessing the water and/or wastewater system. In some cases it may entitle the customer to use up to a fixed amount of water per unit of time e.g., 0.2 m^3 per month at no additional charge.
Future Value Payment	This feature is used to set aside funds today to finance some future investment, such as replacement of a part of the water network or pump station. The "future value payment" is the expected amount of the future investment. The "future value payment" ASTEC computes is a series of annual payments to be made over some planning period and that, as part of the planning process, should be covered by tariffs on the annual provision of water and wastewater services. The usual assumption is that the annual payments are deposited in some form of bank account and accrue annual interest. The annual payment is higher the shorter the planning period, the larger the future investment, and the lower the interest rate paid on the amounts deposited in the bank account.
Independent goods	As used here, the term "independent" goods is used in contrast to "composite" goods. The measurement of consumption and payment for these goods is done completely independently of one another. In this context, this may be the case for water and wastewater services when the wastewater produced by the user is sufficiently large and/or of different enough quality to justify direct metering and/or monitoring.
MWWU	Municipal Water and Wastewater Utility. This may also be a "regional" water system that serves several communities. The MWWU is responsible for providing treated water to customers in municipalities or communities for domestic, commercial, and some industrial purposes. It is frequently also responsible for collecting and treating sewerage produced by its water customers.
Present Value Payment	This feature is used to set aside funds to cover the principal and interest on a loan that has been taken out in the past, or is expected to be taken out during the planning period of this scenario, to make in investment in a water or wastewater system. Such an investment might be replacement of part of the water network or new wastewater pumps. The "present value payment" is the initial amount of the loan, usually at the beginning of a planning period. For a "present value payment", ASTEC computes the annual principal and interest that must be paid in order to retire the loan over the planning period. The annual payment is higher the shorter the planning period, the larger the loan, and the higher the interest rate of charge to finance the loan and is treated by the model as a cost of operating the water or wastewater system.
Real Interest Rate	The real interest rate (r) is defined as the nominal rate of return (n) corrected for the rate of inflation (i). Because of compounding, the real rate should be calculated as r= (n-i)/(1+i), where the terms are the decimal equivalents of the percentage rates.

Term	Explanation
Tariff	Tariff is the price of water and wastewater services.
Service User	A category of service users defined for modeling purposes. Service users belonging to one service user group are not identical, but they have a lot in common, e.g. they consists of only household apartment accounts with approximately the same level of water use.
Unbilled Water	The difference between produced and billed water. Unbilled water may take a variety of forms, such as leaked water from water pipelines; consumed, but not invoiced water; own water use of the MWWU, for instance to flood the pipelines in order to keep them clean; stolen water.
Variable Costs	The variable cost is that cost which varies with the amount of service provided. It is a "marginal" concept in that we ask how many more units of various inputs will be needed to increase output by one unit. This is usually computed for small changes in output in the vicinity of the current level of aggregate output. For larger changes or changes that occur at the very limit of some capacity constraint, the variable cost may include the cost of adding some inputs that have an economic life longer than a year.
Variable Tariff	The "variable tariff" results in an invoice that "varies" with the level or estimated or measured consumption of water or wastewater service. It is the charge per unit of consumption and is therefore denominated in monetary units per physical unit e.g., €/m^3. The variable water tariff as set by the MWWU sometimes varies by the type of customer, the season of the year, or some other criterion selected by the MWWU.

ANNEX 2: EXPERIENCE USING ASTEC

This annex is a copy of a project information document that briefly describes the history of ASTEC and describes some of our experiences using the model. In the process we introduce the reader to the various uses of ASTEC, some of the most valuable of which are incidental to model application rather than the model results per se..

1 THE ORIGINS OF ASTEC

As we met with country experts and municipal water officials during our study of tariff and effluent charge reforms, these experts recounted many common problems – high levels of system water loss, out-of-date equipment and technology, difficulty of raising capital to support investment, changing or uncertain ownership, shifting economic regulation. At the same time, however, there were substantial differences from place to place and country to country. Perhaps most importantly, we commonly encountered different contentions regarding prevalent financial and operating conditions: water systems had an operating surplus or were insolvent, operators were being squeezed by municipal owners or taking advantage of the new owners, owners were approving tariffs that were too high or were not approving the tariffs increases needed to put the water system on solid, long term footing. Of course, all this may be true depending on ones perspective, as well as on the particular water system or institutional setting. What was clear is that both our Project and the policy makers in the region needed some systematic way of evaluating the current status of individual water systems; one that could also accommodate the many differences in national settings and local circumstances. To meet this need, we developed a spreadsheet model, Accounts Simulation for Tariff and Effluent Charge Modeling or ASTEC.

2 WHAT IS ASTEC GOOD FOR?

2.1 Is Your Water System "Broke"?

As the ASTEC name suggests, the model is built around water system accounts: What does the "current account" look like? What are the systems current revenues? What are the systems immediate costs? Instead of simply looking at account totals however, ASTEC asks the user to dig a little deeper. It asks the user to distinguish the current account for water service from the current account for wastewater service – and to leave out account items that don't relate to its core business of providing these water and wastewater services to customers.[12] One the revenue side of the account, ASTEC asks the user to estimate the sources of revenue by each significant customer or "service user" category. How much does this service user group e.g., households in multiunit apartment blocks, use per account? What is the tariff applied to this service user group? What is the expected revenue from this service user group? On the cost side of the current account ASTEC asks for the costs of providing current levels of service? It asks the user to provide separate information on operating and capital costs in the current period. It also asks the user to

[12] Under new municipal or private ownership in CEE, the trend has been to break up integrated municipal service companies and create separate water utilities. This makes the job of creating separate water system accounts more tractable for ASTEC users.

assign these costs to particular service users e.g., what fraction of operating costs is due to provision of water service to the large industrial users on the northwest side of the city?

With this information, along with some other technical and financial data e.g., aggregate water production and wastewater treatment, accounts in arrears, etc., the ASTEC user can estimate the current budget balance of the water system. In other words, under current conditions, including tariff levels, does this system have the income necessary to meet it immediate bills? Or does it have to depend on some transfers from outside the water system or revenues from non-core operations to keep itself afloat. Most water systems we encountered were in "current account" balance. Even so, it was important to our work – and that of water system managers – to have the fresh and systematic look at the water system's short term financial condition that ASTEC provides and to identify those systems with current budget deficits, even if such systems are in the minority.

2.2 Is Your Water System Financially Sustainable?

A water system may not be "broke", but can it reasonably expect to be a self-sustaining entity for years into the future? This question is particularly important for water systems that, like many of the systems in the DRB, operated until recently in economic systems where infrastructure and equipment were financed externally at no direct cost to the water system and its customers.

ASTEC examines this question by enlarging the baseline set of accounts for a given water system to include capital elements, especially depreciation of infrastructure and investment programs to maintain, repair, and replace plant and equipment. Given these baseline data, ASTEC can be used to evaluate a system's financial sustainability. Moreover, if the water system does not appear to be sustainable, ASTEC can also be used to examine what tariff and related policy reforms can assist in transforming that water system into one that is.

ASTEC can approach achieving financial sustainable from several perspectives, individually or in combination:

- What tariff levels will balance system costs and revenues at current service levels?
- What invoice recovery strategies will increase revenues?
- Are there cost saving investments that can be made? In the water system? In wastewater system?
- Can operating costs be reduced without impairing services?

These questions suggest some of the capabilities of ASTEC. It can take account of simultaneous changes in the water tariffs and water consumption, or of improved collection rates and an investment in leakage reduction in the water network, or of an investment activity that is also labor-saving. Whatever the policies under consideration, if they can be described by changes in system tariffs and costs and, in the case of investment costs, linked to the physical performance of the system, ASTEC will compute a new system financial balance and, in so doing, estimate how close to sustainability the system will be with the new program and policies.

2.3 We Just Lost Hundreds of Customers!

Translating existing system data – billing data, accounting data, and technical data - into an ASTEC spreadsheet has invariably provided a useful cross-check on these data. One water system that

implemented ASTEC discovered that they had hundreds fewer customers than they thought. It tuned out that customer account data were not regularly purged when customers moved or dropped off the water system, so hundreds of ghost customers remained in the billing data of the water system. This discrepancy was discovered because ASTEC's method of independently computing baseline conditions showed higher consumption (and revenue) than in the water system's annual financial report.

Our experience is that ASTEC implementation often leads to the discovery of a wide variety of data and policy anomalies in a water system. Problems of cost allocation, customer billing, tax payments, and payment avoidance that weren't known or full appreciated before-hand by the system operators and managers (or by consultants like us) have been identified or highlighted simply as a result of efforts to implement a current account baseline using ASTEC.

2.4 That's Not What We Mean by "Amortization"!

In several water systems we have worked with, the amortization charge in their accounts was not linked to repayment of the principle and interest on a commercial loan – the common usage in English – but to an estimate of the annual value of system depreciation. In another water system we worked with, the "development fund" was not used for development but for maintenance. In that same water system, household customers were identified as "metered" when the meter in question covered an entire apartment block. In yet another instance of confusing terminology, an accounting item labeled as "profit" was actually a rental payment on capital infrastructure used by the water system but owned by the city.

Economic, technical, or finance terminology, compounded by language differences, can often foil identification and treatment of serious financial difficulties. We all too commonly mis-understood or mis-interpreted data provided by the water systems. At the same time, water system staff sometimes misunderstood the organizing principles used in setting up ASTEC accounts, principles that we thought were self-evident but which, in retrospect, needed to be more clearly and effectively conveyed. The simple process of entering data in proper locations and in the proper way in the ASTEC spreadsheets often revealed a wide variety of such problems and helped us identify, confront, and correct them.

2.5 Can the Water System and Its Customers Support Expansion and Upgrades?

For many water systems of the DRB the current challenge goes beyond sustaining current services to up-grading or expanding them to meet the needs of their customers or new health, safety, or environmental regulations. Since providing these additional services requires additional resources, the water systems find themselves trying to balance the various demands for up-grades against the burdens these up-grades place on its finances and customers. ASTEC can examine the impact of service provision and service costs for a wide variety tariff, administrative, and investment policies, both individually and in combination. It allows the user to examine the different impacts of different programs, not simply to cost out a given program.

2.6 What Investments are Cost-Effective?

One water system we are familiar with was taken to task for having water losses that were outside the range of a "well-managed" system. In this case, nearly 50% of the water produced by the system did not reach its customers. An investment program was proposed to reduce the water system "leakage" to a target level of 25%. When this investment program was examined with ASTEC, however, it was discovered that many of the investment components actually increase the net cost of providing water service. This locality is blessed with very productive, high quality water resources. Water production costs are so low that it simply would not pay to aggressively replace parts of the water system to reduce leakage. ASTEC can be used to screen out upgrades that, while advisable in some settings, are not even cost-effective your system's particular circumstances.

2.7 Fine-Tuning Investment Programs and Tariff Policies

One water system we working with is committed to building a new wastewater treatment plant (WWTP) but the best combination of design choices and complementary investments is not clear. The cost and revenues of the WWTP depend on the capacity and extent of treatment of the plant; other investments in the wastewater network and storm water holding basins; as well as anticipated industrial pre-treatment, and industrial use of the WWTP. While external financial assistance is available in a fixed amount, the water system if responsible for covering the residual capital and operating costs. We have helped this water system implement ASTEC and are assisting the water system in examining strategic choices regarding plant design, complementary investments, and tariff designs and levels.

2.8 Choosing an Investment Strategy

Some water systems aren't sure what their broad investment strategy should be because they have lots of options and no way to systematically evaluate them. Implementing ASTEC can help these water systems not only choose among investments but assess whether the increased costs are commensurate with the improvement in services. This later assessment cannot be done directly by ASTEC – it does not evaluate improvements in service in a monetary measure that may be compared directly with the increase in cost. Given water system tariff policy, however, ASTEC can compute the tariff levels required to cover the investment option. Water system policy makers can then assess whether the service improvements associated with the investment justify the estimated tariff increases.

Many water systems in the DRB are obliged by national policy to meet certain service targets. Commonly, however, local resources are not sufficient to meet these targets in full or all at once. The water systems must consider a phased investment strategy and ASTEC scenarios can be used to both select a cost-effective sequence of investments and to demonstrate the burden of a more aggressive strategy to national policy makers. Aside from the tariff levels per se, ASTEC also computes the average or typical expenditures of various service user categories. These data, together with household or firm budget data, can be use to produce various the "burden indices" that highlight the limits of local resources for the consideration of policy makers locally and at national and international institutions.

2.9 Who Knew?

In one water system we worked with, households had substantially lower tariffs than commercial/industrial customers. While using ASTEC to examine new of tariff policies to support system upgrade, it was discovered that over eighty public (but commercial) customers had been classified as households. This discovery, and the subsequent change in classification, had an immediate impact on system revenues (and the tariff scenarios developed as part of the ASTEC-based analysis). Once again, the process of using ASTEC – in this case to explore system up-grades – produced information that was news to policy makers and of direct value to the water system.

3 WHAT DOES ASTEC COST?

The direct, but misleading, answer is "nothing". The ASTEC software is as an application of the Microsoft Excel spreadsheet system and associated "macro" tools. If one has a computer with a recent version of Excel installed with the "Solver" macro, one can download and use ASTEC and its multiple spreadsheets free of charge.

On the other hand, it is expensive to introduce a new water system in ASTEC. The ASTEC model requires substantial data input, familiarity with the way excel software works, and training in some economics and finance principles to assure proper implementation of scenarios and interpretation of results. The data inputs, as described above, are rarely available without a coordinated and concerted effort on the part of the accounting, engineering, and finance sections of a water system. While some data may be right at hand, other data must be gathered, developed or estimated. While, as noted above, this process often has benefits in its own right, it is often arduous, demanding reconciliation of conflicting information, as well as development of new information, for use in ASTEC.

The ASTEC spreadsheets are laid out in what we think is a fairly orderly and transparent way. They are also laden with headings, comments, and alerts that help guide the user's understanding of the significance of an entry and to protect the user from making a mistake. For example, if entries in several fields are in logical conflict, ASTEC will alert the user to this problem. Similarly, when one changes a scenario ASTEC asks if the user also wants to change the description that accompanies the scenario before allowing the user to save that version of ASTEC. Despite these "user friendly" features, the enormous flexibility and range of ASTEC has also meant that the software is best described as complicated and demanding of the user's care and attention. To implement, use, and interpret ASTEC correctly, the user (or user group) needs a good understanding of how the software is structured and an appreciation for the basic mathematical, economics, engineering, and accounting principles represented in the functions and operations of the model. While it is possible for a "naïve" user to quickly get a feel for ASTEC and to run ASTEC scenarios, we do not recommend such use of ASTEC unless it is done under the tutelage of an experienced user.

Of course, having made the investment in learning about ASTEC and implementing it for a particular water system, the user is in a position of explore, update, and re-examine most any policy change or investment program that comes to mind. This provides a wonderful feeling of competence and power. We hope that many water system staff get to experience this feeling while using ASTEC in the near future.

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